U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-269 413

Estimation of Live Fish Weight by Photography

Environmental Research Lab -Duluth, Minn

18 Aug 76

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-600/3-77-027	2. JOURNAL ARTICLE
3.	PB 269 413
4. TITLE AND SUBTITLE: ESTIMATION OF LIVE FISH WEIGHT BY PHOTOGRAPHY*	5. REPORT DATE
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S): Glenn M. Christensen, James T. Fiandt, and Duane A. Benoit	8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Duluth MN 55804	10. PROGRAM ELEMENT NO. 1BA608
	11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS: Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Duluth MN 55804	13. TYPE OF REPORT AND PERIOD COVERED: Journal article
	14. SPONSORING AGENCY CODE: EPA/600/01

15. SUPPLEMENTARY NOTES: CONTACT: G.M. Christensen, 8-783-9556 (Duluth, MN)
*as published in Progressive Fish-Culturist 39(1):41-42 (1977).

16. ABSTRACT

Approximate weights of fish were calculated from length and width measurements of their photographic images. In the calculations we employed the formulat Wt = KLW^2, where Wt = weight (g); K = proportionality factor, derived from a subsample of the population under study; L = length (cm); and W = width (cm). When tested against true weights, the derived weights had a mean error of ± 8.6%.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Fish Weight Indicators	DF, RT Weight measurements	06C 14B

REPRODUCED BY NATIONAL TECHNICAL INFORMATION SERVICE U.S. DEPARTMENT OF COMMERCE SPRINGFIELD, VA. 22161

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS (This Report)	21. NO. OF PAGES 4
	20. SECURITY CLASS (This page)	22. PRICE PC A01/MF A01

EPA Form 2220-1 (9-73)

EPA-600/4-77-027
JOURNAL ARTICLE

Estimation of Live Fish Weight by Photography

Glenn M. Christensen, James T. Fiandt, and Duane A. Benoit

U.S. Environmental Protection Agency, Environmental Research Laboratory – Duluth
6201 Congdon Boulevard, Duluth, Minnesota 55804

ABSTRACT: Approximate weights of fish were calculated from length and width measurements of their photographic images. In the calculations we employed the formula $Wt = KLW^2$, where Wt = weight (g); K = proportionality factor, derived from a subsample of the population under study; L = length (cm); and W = width (cm). When tested against true weights, the derived weights had a mean error of ±8.0%.

Photographs of live fish have previously been used for determining the length of particularly small fish in groups (Bushuev 1968; Martin 1967) and for estimating weight based on a determination of the lateral area of photographic projection of single fish in a special chamber (Hawkes 1975). This procedure generally involved little fish handling and relatively simple techniques, and groups of fish could be measured with reasonable precision and accuracy in a short time.

The principal formula previously used to equate length with weight was $Wt = aL^n$, where Wt = weight, a = a constant, L = length, and n = an integer, usually 3 (Brown 1957; Lagler 1969; Lagler et al. 1962); a significant limitation was that only length was measured. Since fish may vary in unequal ratios of weight, width, height, and length, Hawkes (1975) included the measurement of both height and length to attain increased accuracy. The values derived by this method were then correlated with dry weight values previously obtained from a group of fish. This method, however, was designed for individual measurements of relatively large fish.

The method reported here incorporates the advantages of photography and represents an improvement in accuracy not only in estimating the approximate weight of fish but also in determining other factors derived from weight, such as growth rate.

In one of our recent experiments it was desirable to ascertain the weekly growth rate (in terms of weight change per unit of time) of groups of young brook trout (*Salvelinus fontinalis*). The groups (each about 20 fish, 4 to 26 weeks old) were maintained in glass growth chambers (13 x 38 x 15 cm), which were designed to be removed from supporting tanks and drained to a water depth of about 2.5 cm. These chambers were then placed over a sheet of millimeter graph paper positioned above fluorescent light (McKim and Benoit 1971). The fish were then photographed with a 35-mm camera placed on a tripod about 75 cm above the chamber. We used Kodak Tri-X Pan film ASA 400[1] (Eastman Kodak Co., Rochester, New York) f11 at 1/125 s; after development, the negatives were enlarged to 20 x 25 cm and printed with a 3M 400 reader-printer, 18.25× lens (Microfilm Division, Minnesota Mining & Manufacturing Co., St. Paul). Dorsal-view images were projected on the grid so that dimensions of individual fish could be determined. For fish in a curvilinear display, a drawing compass was used as an aid in obtaining total length. We measured the width of each fish at a position one third of the distance from head to tail.

The simple equation we developed to derive the weight of each juvenile fish stems from the relationship $V = LWH$, where V = volume of a rectangular prism (cc), L = length (cm), W = width (cm), and H = height (cm). The density of the fish was assigned as 1.00, and the volume was thus equated to weight (in grams). Because height could not be measured in such a vertical photographic projection, width was substituted for height, and the formula thus became $Wt = LW^2$. A proportionality factor, K, was then introduced, providing the final equation, $Wt = KLW^2$.

To evaluate the constant, K ($K = Wt/LW^2$), and to determine the accuracy of this method for estimating fish weight, we sacrificed 75 brook trout pairs (18 weeks after hatching), and measured their length, width, and weight. A value for K was determined for each fish; the mean value was 0.810 (variance, 0.0003; SD, 0.0087). Using K = 0.810, we calculated a weight value for each fish which we compared to its measured (true) weight; the mean variability for these 75 pairs of numbers was ±8.0%. To demonstrate that this procedure provides a better evaluation of fish weight than one that involves only length measurements, we restudied the 75 specimens using the formula $Wt = KL$, considering K as the proportionality factor. Individual values and then a

[1] The U.S. Environmental Protection Agency neither recommends nor endorses any commercial product; trade names are used only for identification.

mean value for K (namely 0.443) were determined. Using K = 0.445, we obtained a calculated weight for each fish which we compared to its measured (true) weight; the mean variability between the 75 pairs of numbers was ±23.2%. The mean value for K (0.510) was nearly constant when it was determined on miscellaneous groups of brook trout fry, varying in age from 4 to 26 weeks. Lengths and widths were measured with calipers to the nearest 0.2 mm and weights were measured after the fish was blotted for 1 min.

The factor K may vary with fish species; it will vary within a species if the density varies from unity or if the width-to-height ratio varies because of age, changes in water quality, or for other reasons. An experimental determination of K is required if it is known or suspected that a previously established value is no longer applicable.

This method of weight analysis, based on measurements of two dimensions of fish, may be particularly useful in carrying out growth-rate studies. If size-time increments adequately indicate growth rate (Rounsefell and Everhart 1953), this method will show the degree of change (negative, positive, or zero), and provide corollary indications of catabolic, anabolic, or balanced (resting) metabolic conditions. In certain current studies with fish exposed to debilitating concentrations of water pollutants, we observed a negative growth rate, which we interpreted as being an initial sign of distress; the later deaths of the fish indicated that they were under a terminal degree of stress.

Acknowledgment

We thank N. Joyce and G. Holcombe for technical assistance.

References

Brown, M. E. 1957. Experimental studies on growth. Pages 370-372 in The physiology of fishes. Vol. 1. Academic Press, Inc., New York.

Buchanan, V. P. 1960. Measuring fish larvae and fry by means of photography. Rybn. Khoz. 5:13-14.

Hawkes, C. L. 1975. Estimating dry weight of live unanesthetized fish by photography. J. Fish. Res. Board Can. 32:321-324.

Lagler, K. F. 1960. Length-weight relationships and condition. Pages 159-164 in Freshwater fishery biology, 2nd ed. Wm. C. Brown Co., Pubs., Dubuque, Iowa.

_____, J. E. Bardach, and R. R. Miller. 1962. Growth of fishes. Pages 172-173 in Ichthyology. John Wiley & Sons, Inc., New York.

Martin, J. W. 1967. A method of measuring lengths of juvenile salmon from photographs. Prog. Fish-Cult. 29(4):238.

McKim, J. M., and D. A. Benoit. 1971. Effects of long-term exposures to copper on survival, growth, and reproduction of brook trout (Salvelinus fontinalis). J. Fish. Res. Board Can. 28:655-662.

Rounsefell, G. A., and W. H. Everhart. 1953. Growth. Pages 311-323 in Fishery science. John Wiley & Sons, Inc., New York.

Accepted 16 August 1975.